

# INVISTA TERRIN™ Polyols

Cost-Effective Alternative to Conventional Polyether and Polyester Polyols

**Introduction** TERRIN™ polyols can be used in lieu of or in combination with conventional polyether or polyester polyols to formulate a variety of polyurethane products designed to be soft and flexible—or hard and stiff. These versatile, aliphatic, polyester polyols can be used in applications ranging from viscoelastic foam to spray coatings and adhesives to elastomeric resins. TERRIN™ polyols:

- Are cost competitive in comparison to conventional polyols
- Contain a minimum of 50% recycled or renewable<sup>1</sup> content
- Have similar hydroxyl values to castor oil, and can be substituted on a nearly equal weight basis
- Are REACH and TSCA compliant

In addition, TERRIN™ polyols are an easily handled, low-viscosity liquid at room temperature. TERRIN™ product offerings—especially 168 and 168G—remain pourable liquids at -15°C/5°F and below<sup>2</sup>. TERRIN™ polyols do not crystallize and exhibit T<sub>g</sub> in a range of approximately -60°C to -75°C.

## **Application** Alternatives to Castor Oil in Polyurethane Formulations

This Technical Data Sheet is intended to illustrate how PU prepared using TERRIN™ polyols compare to similar PU prepared using Castor oil. The simple formulations herein are not optimized, aren't intended to cover the entire range of possibilities, and are not targeted at any specific application, but are meant to provide the experienced polyurethane formulator with ideas and starting points for application-specific formulations. The information set forth herein is furnished free of charge and is based on technical data that INVISTA believes to be reliable, provided that INVISTA makes no representation or warranty as to the completeness or accuracy thereof. It is intended for use by persons having technical skill, at their own discretion and risk, who will make their own determination as to its suitability for their purposes prior to use. As with any material, evaluation of any compound under end-use conditions prior to specification is essential. Nothing herein is to be taken as a license to operate under or a recommendation to infringe any patents. In no event will INVISTA be responsible for damages of any nature whatsoever resulting from the use of or reliance upon the information contained herein or the product to which the information refers.

<sup>1</sup>As defined by ISO 14021, Section 7.8; preliminary estimate based on small-scale production.

<sup>2</sup>Patents pending; consult the SDS for additional physical-chemical, safety and health information

## Features

With 100% aliphatic ester content, TERRIN™ polyols offer the polyurethane (PU) formulator several new alternatives to castor oil polyol. With similar hydroxyl value to castor oil, TERRIN™ polyols can be substituted for Castor oil on nearly an equal weight basis. A balance of PU properties may be achieved similar to those obtained using Castor oil or the formulator may choose to optimize selected more important properties over others to satisfy end-use requirements.

- The supply of TERRIN™ polyols is not dependent on weather and planting cycles
- TERRIN™ polyols are manufactured in the USA
- TERRIN™ polyols contain at a minimum of 50% recycled content; some members of the TERRIN™ polyol family also contain renewable content

## Preparation

Ingredient quantities shown in Table 2 are in parts by weight. Diethylene glycol (DEG) was used as chain extender in these examples. The hard segment comprises the isocyanate and chain extender (if any). All formulations are at Isocyanate index of 105, meaning a 5% molar excess of isocyanate relative to hydroxyl. No catalyst was used.

Polyurethanes were prepared by the “one shot” method wherein all ingredients are combined, mixed, cast onto a flat glass plate, de-gassed, and heated to complete cure. After curing, specimens were cut for physical properties testing.

Table 1: Characteristics of TERRIN™ polyols and castor oil

Parameter	TERRIN™ 168	TERRIN™ 168G	TERRIN™ 170	Castor Oil
Hydroxyl number <sup>1</sup>	160-180	160-180	160-180	160-168
Viscosity, cSt	315	750	5000	630-890
Acid number <sup>1</sup>	1.5 max	1.5 max	1.5 max	2.0 max
Water content, wt % <sup>1</sup>	0.1 max	0.1 max	0.1 max	0.35 max
Specific gravity (25°C/25°C)	1.113	1.133	1.146	0.957-0.961
Typical functionality	1.8	2	2.2	2.7
Type of hydroxyl	Primary	Primary and Secondary	Primary and Secondary	Secondary
Recycled content <sup>2</sup>	Yes	Yes	Yes	No
Renewable content <sup>2</sup>	No	Yes	Yes	Yes

<sup>1</sup> Property is included in the TERRIN™ polyol product specification

<sup>2</sup> As defined by ISO 14021, Sections 7.8 and 7.14; consult individual Product Data Sheets for more information

Table 2: Polyurethane Formulations

Formulation	Polyol	Isocyanate <sup>3</sup> (Rubinate <sup>®</sup> M <sup>3</sup> )	Chain Extender (DEG)	Hard segment (weight %)	
1	TERRIN™ 168	70.05	29.95	None	30
2	TERRIN™ 168	60.00	36.12	3.88	40
3	TERRIN™ 168	50.00	42.25	7.75	50
4	TERRIN™ 168G	70.00	29.90	0.1	30
5	TERRIN™ 168G	60.00	36.05	3.95	40
6	TERRIN™ 168G	50.00	42.19	7.81	50
7	TERRIN™ 170	70.31	29.69	None	30
8	TERRIN™ 170	60.00	36.21	3.79	40
9	TERRIN™ 170	50.00	42.18	7.82	50
10	Castor oil <sup>4</sup>	70.40	29.60	None	30
11	Castor oil <sup>4</sup>	60.00	35.99	4.01	40
12	Castor oil <sup>4</sup>	50.00	42.15	7.85	50

<sup>3</sup> Rubinate<sup>®</sup> M PMDI, available from Huntsman Corporation

<sup>4</sup> DB<sup>®</sup> Castor Oil, available from Vertellus Specialties

## Results

Hardness was measured by durometer on the Shore D scale. Tensile strength and elongation were measured by testing dogbone specimens (ASTM D412 Die C) on an Instron<sup>®</sup> tester. Glass transition temperature (T<sub>g</sub>) was measured by dynamic mechanical analysis (DMA); values are reported from the peak of the tan δ or loss modulus curves vs. temperature.

Table 3: Polyurethane Test Results

Formulation	Polyol	Chain extender	Hard seg (wt %)	Hardness (Shore D)	Tensile Strength (psi)	Elongation at break (%)	T <sub>g</sub> (tan δ)	T <sub>g</sub> (loss mod)
1	TERRIN™ 168	None	30	29	75	103	11	-3
2	TERRIN™ 168	DEG	40	32	278	115	23	12
3	TERRIN™ 168	DEG	50	60	1092	72	44	27
4	TERRIN™ 168G	None	30	26	174	34	25	8
5	TERRIN™ 168G	DEG	40	43	421	59	34	18
6	TERRIN™ 168G	DEG	50	69	2321	41	50	34
7	TERRIN™ 170	None	30	51	1174	54	45	17
8	TERRIN™ 170	DEG	40	69	2025	39	60	32
9	TERRIN™ 170	DEG	50	77	3307	4	69	47
10	Castor Oil	None	30	31	632	62	29	14
11	Castor Oil	DEG	40	55	853	39	42	28
12	Castor Oil	DEG	50	55	1072	1	47	28

Figure 1 graphically compares the PU made at 30% hard segment (numerical data given in Table 3). Each axis (test parameter) was scaled by setting the maximum value observed over all 12 formulations equal to 10 and scaling the other values accordingly. Figures 2 and 3 provide similar comparisons of PU made at 40% and 50% hard segment respectively, using the same scaling so that the figures can be compared easily. For example, highest elongation is obtained with TERRIN™ 168 at 30% hard segment. Highest hardness, tensile strength, and  $T_g$  are obtained with TERRIN™ 170 at 50% hard segment.

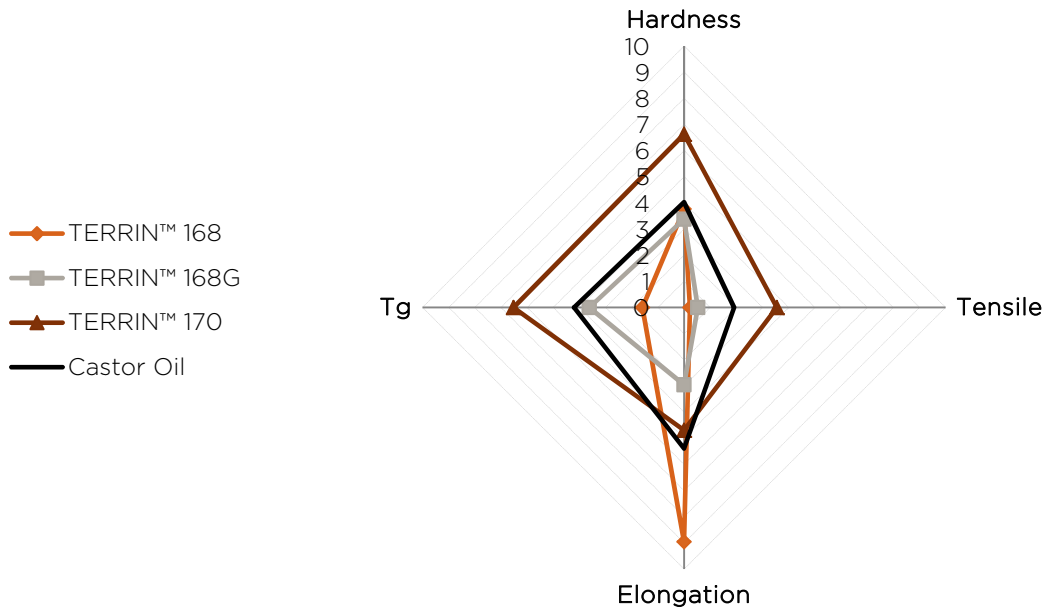


Figure 1: Properties of PU made with 30% hard segment

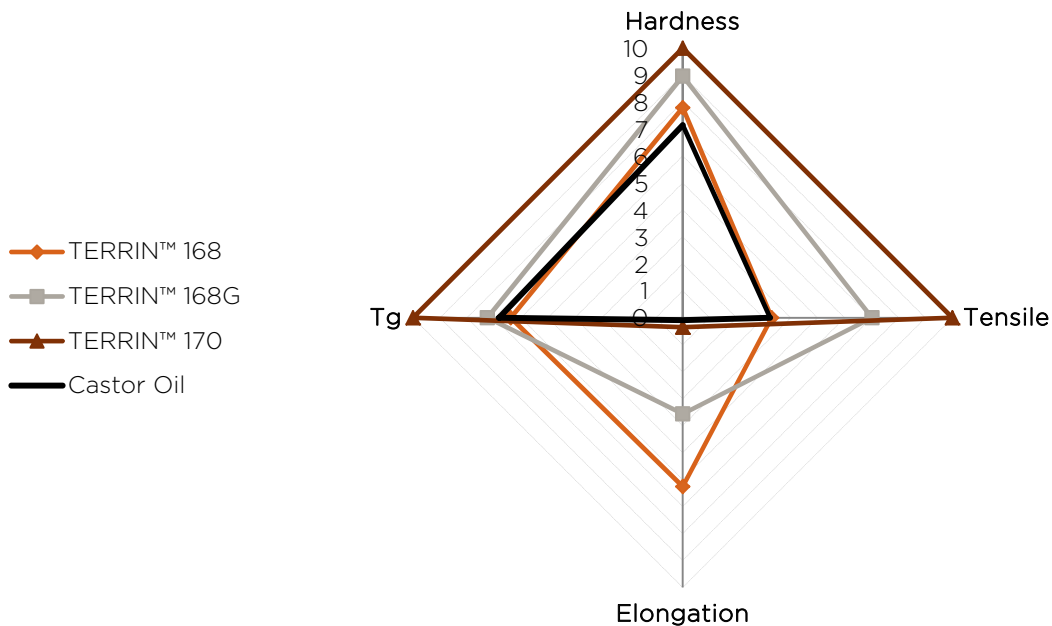


Figure 2: Properties of PU made with 50% hard segment



[www.TERRIN.INVISTA.com](http://www.TERRIN.INVISTA.com)

For samples and further information please contact:

1.800.231.0998 | [TERRIN@INVISTA.com](mailto:TERRIN@INVISTA.com)

This Product Data Sheet contains selected information about a specific INVISTA product, or group of products, and particular uses of the same. It relates only to the identified product and any identified uses, and is based on information available as of the date hereof. Additional information may be needed to evaluate other uses of the product, including use of the product in combination with any materials or in any processes other than those specifically referenced. Information provided herein with respect to any hazards that may be associated with the product is not meant to suggest that use of the product in a given application will necessarily result in any exposure or risk to workers or the general public. This product data sheet does not contain a complete statement of, and does not constitute a representation, warranty or guaranty with regard to, a product's characteristics, uses, QUALITY, merchantability, FITNESS FOR A PARTICULAR PURPOSE, or the suitability, safety, efficacy, hazards or health effects of the product, whether used singularly or in combination with any other product, EXCEPT TO THE EXTENT REQUIRED BY THE RELEVANT LAW AND REGULATIONS. Purchasers and users of the product are responsible for determining that the product is suitable for the intended use and that their workers and the general public are advised of any risks resulting from such use. Nothing contained in this Product Data Sheet shall be construed to modify any of the commercial terms pursuant to which the product was sold by INVISTA including, but not limited to, terms and conditions addressing each party's respective rights and obligations with regard to warranties, remedies and indemnification.

If purchasers and users believe or have reason to believe that the Product Data Sheet or other information provided to them by INVISTA is inaccurate or in any way insufficient for any purpose, they should immediately notify INVISTA of the same, and of the basis for their belief (for example, studies, data, reports of incidents, etc.) so that INVISTA can determine whether modification or supplementation of the Product Data Sheet, or other measures, are appropriate. Failure of purchasers and users to timely provide such notice shall be deemed a waiver by purchasers and users of any and all claims, demands or causes of action, including causes of action based on an alleged failure to warn, for personal injury or damage to the environment or property arising from or attributable to the use of product.

This disclaimer shall be effective to the extent allowed by law. Should any provision be deemed to be ineffective or unenforceable, that provision shall be deemed severed from the disclaimer and the remaining provisions shall continue to have full force and effect.